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| **Challenge/ Issues – Found in Key Stages of Development** | | | |
| Link to Key Stages of Learning | Issue/ Challenge | Origin/ Explanation of Challenge - Links to literature | Suggested Classroom Practice |
| a1-a6 | Difficulties making sense of fraction diagrams and line models (Symbolic Phase) | As with all major concepts that are embedded throughout the curriculum, knowledge and understandings of fractions is developed as a progression from basic concepts through to advanced understandings (*ACARA, 2012*). Consequently, if students miss or struggle to comprehend a new topic or phase of development there may then be a gap in their knowledge regarding fractions. This notion is identified within this challenge. In order for students to attain competence when working with fraction diagrams and line models they must first have developed a sound understanding of the basic principles of fractions. The reason as to why students struggle with this concept is not always due to this concept on its own, misunderstandings and gaps may have been developed at an earlier stage (*Siemon et al, 2011*).  Challenges and issues are more uncommon at the material phase as students can clearly see and manipulate a fraction of a solid object (*Siemon et al, 2011*). It is when students are introduced to the symbolic phase before they are ready that challenges and issues arise. (*Siemon et al, 2011*). | To rectify this challenge it often becomes pertinent to refer back to the concrete/ material phase of learning (*Siemon et al, 2011*). By participating in and re-visiting this process, students often gain a greater depth of understanding regarding the topic and as a result are then able to effectively transfer this new knowledge into more advanced processes including the understanding of fraction diagrams and line models (*Siemon et al, 2011*). |
| a1, a2. | Using circular shapes to represent fractions as this may become difficult to identify and compare equal parts and regions for students who are beginning to develop an understanding of fractions | According to Siemon et al (*2011*) in the beginning stages of development, the concept of fractions should be taught through the use of rectangular or square shapes rather than utilising circular objects. As square based objects more clearly illustrate the regions/ parts of each fraction and are more easily compared.  Square and rectangular shapes allow for equal parts to be more easily and accurately identified and created, which is a crucial aspect of fraction knowledge (*Siemon et al, 2011*). Often when students are presented with circular or irregular shapes (especially during early stages of knowledge development) the underlying concepts are missed as students focus more on deciphering the shapes rather than the knowledge that is aiming to be developed (*Siemon et al, 2011*). | This challenge can be acknowledged during classroom practice by introducing fraction concepts using square- based shapes, for example: 1/4   |  |  | | --- | --- | |  |  | |  |  |   Rather than the use of circular shapes to begin with (as students begin to develop a greater understanding, circular shapes should then be incorporated) |
| d1-d4, f1-f2 | Students do not have sufficient understanding of division and multiples. This knowledge is relevant to developing a comprehensive recall of common multiples as this becomes necessary when simplifying fractions and determining common denominators | This challenge originates due to students possible lack of knowledge regarding basic recall of number facts, common multiples and factors (*Siemon et al, 2011*). A lack of knowledge regarding these aspects can have implications across all areas of mathematics (*ACARA, 2012*). With regards to fractions and decimals, this issue may hinder students accuracy and speed while determining common denominators (addition and subtraction of fractions), identifying factors and multiples while simplifying or calculating lowest possible form (*Siemon et al, 2011*). This challenge also highlights a students’ ability to ‘trust the count’ *(Siemon et al, 2011*). | This challenge lends itself to classroom practice in a wide variety of areas. For the purpose of this task some common and simple suggestions are offered below:   * Number fact quizzes – aiming for accuracy before speed * Around the World – with number facts * Factor Trees * Identifying Multiples |
| a4, a5 | When comparing two fractions, students tend to only look at the numerator, and disregard the denominator. This leaves students identifying for example 4/10 as a larger fraction than ½ as they just recognise that 4 is larger than 1. Students must learn that in order to compare fractions and make fair comparisons, an equivalent denominator must be determined (C. Attrill, et al. 2009). | Students often become confused with fractions because of the language that is used to describe the number (ones and parts).  The number written above the line tells how many parts, the line symbolises out of and the number beneath names the size of the parts. It is crucial for the learning manager to use the correct terminology to ensure that students can understanding and make connection with fractions, decimal fractions and place value (Booker, Bond, Sparrow, Swan, 2010) | The learning manager should ensure careful consideration is used when introducing fractions and that it relates to the construction of the model (3 parts out of 5 equal parts) is the key to establishing a thorough understanding.  Students need a thorough understanding of the symbols used in fractions in order for them to understand the ways in which common fractions can be renamed (improper fractions, mixed numbers etc).  Teachers may like to ask student to construct diagrams and shade in parts (Booker, Bond, Sparrow, Swan, 2010) |
| b1, b2 | When determining the value of decimal numbers (decimal columns represent numbers, however they are written in reverse order) eg: hundreds of less value than tenths). The relationship between place value and language used. Students develop an understanding that tenths are larger than hundredths and thousandths. Works in the opposite direction to whole numbers. | The reading and writing of whole numbers has been based on place value so that 6341 is read as six thousand, three hundred and forty one, rather than said as single digits. Students need to understand that this is the same for decimal fractions. | Teachers need to teach the correct way to read decimals with students and build on the explicit knowledge of place value and the ideas developed through the partitioning process. It should be that 6.3 is read and taught to students as 6 and 3 tenths rather than spelled out as six point three or six decimal three. The teacher may like to use a table chart with heading columns along the top reading thousands, hundreds, tens, ones, decimal, tenths, hundredths, thousandths etc. |
| c1, c2 | Identifying connections between fractions and decimals. When decimals are introduced prior to fractions the links and connections between the two are not made | Although the region model and the language are the same for all forms of fractions, the symbols used to record them are quite different. Decimal fractions and numerations are based on place value providing a consistent link with basic number knowledge, but common fractions look very different as you cannot extend the place value to cope with all the fractional names, meaning that the use of decimal fractions is everyday situations is far more prevalent then common fractions (Booker, Bond, Sparrow, Swan, 2010). | Students need to understand that a fraction is a part of a number and the use of materials is important when establishing fraction ideas. Students need to be familiar with the idea that decimal fractions can represent percentage and proportion.  The teacher may like to use number lines that show fractions are parts of 1 one, 2 ones, 3 ones and name them as proper or improper fractions, mixed numbers, decimal fractions and per cents (Booker, Bond, Sparrow, Swan, 2010). |
| d1-d4 | Recognising that fractions can be represented in different forms – mixed numbers, improper fractions | Fractions include a strong focus on the **reasoning** skills, comparing fractional amounts and exploring equivalence which aligns with the proficiency strands (McLeod & Newmarch, 2006, p.4). At this stage, physical materials are not as helpful. Students need to experience partitioning themselves (Booker et al, 2004, p.134).  Shading equal parts of 1 is preferable as a proper fraction. Then extending to improper fractions requires shading parts of more than one. Students will see parts shaded that extend more than 1 whole number (Booker et al, 2004, p.135). Improper fractions can be seen as 2 ones, example 7/4. Students can display their understanding on number lines and simultaneously demonstrate improper fraction as a mixed fractions and decimal place. | Activate background knowledge of where improper fractions may be used. Using a gradual release of instruction with appropriate scaffolding.  Begin with dividing 4 equal parts of one number using a rectangular region model, then a second number. Have the students shade 7 fourths. They will shade one whole number and three parts of the second number. Once this knowledge is established, other shapes that are equally divided can be shaded. Then this knowledge can be displayed on a number line (this theory drawn from Booker et al, 2004). |
| e1, e2 | Fractions are less than one whole. Students need to understand that improper fractions can be converted into mixed numbers, meaning more than one whole. Students need to begin to work with a range of improper fractions and mixed number in a variety of different contexts (C. Attrill, et al. 2009). | If 0.3, is 3 tenths, then how does the common fraction denominator 3, as in 1/3, fit to this? This uncertainty creates difficulty and gaps in learning.  Discuss these issues prior to the introduction of common fractions and place value to help establish meaning.  Using a rectangular region model is the first step, to ensure meaning is made.  Then using language and symbols is next. A strong practice in this area is critical (Booker et al, 2004). Board games represented in Booker help(2004, p.157).  To overcome this problem, teachers need to state the importance of drawing in that 1 can be represented in different ways. For example, 3 thirds, or, 7 sevenths, or 9 nineths. This is the first step to renaming common fractions. Include using mixed fractions and improper fractions. Students will see the denominator different to just decimal place understanding (tenths, hundredths, etc).  These skills need to be established prior to the beginning of calculations with fractions. | Discuss problem with place value’s and common fractions. For example, 3 tenths is 1/3.  Use rectangular region model as one whole divided into 3 equal parts and ensure students understanding that 1 shaded box out of 3 is 1 third. Do this with other common fractions.  Extend by linking this with written language. For example, 1 out of 3 equal parts, or, 1 third, or 1 out of 3, or 1/3.  The solution is to extensively practice using language and shading of regions which clarify mixed/improper/common fractions and continually point out that 1 is also represented as 3/3, 9/9,6/6 etc. |
| c1 | Identifying the correct value of the denominator when converting decimals to fractions (0.3 could be identified as 1/3 rather than 3/10). | Ensuring students have a good sense of partitioning 1 as 10 tenths, and 100 hundredths is first. Only then, the teacher can move to thousandths.  An understanding of place value is the key to introducing thousandths (Booker et al, 2004). There is no room for partitioning. Using materials, then symbols and language is the process for this process.  Therefore, ensuring that students have a clear understanding of the thousands, hundreds, tens, ones, which can then cross over to the tenths and hundredths is established. Then this can be extended to thousandths. Students will see a pattern (Booker et al, 2004). | Practicing with materials and partitioning to ensure meaning to hundredths is the first step. Focus on correct language use and symbols too.  Have students write numbers that include thousands and hundredths. Divide these into place value. Write the language that represents these numbers. Ensure good meaning is established at this stage. Then introduce next place value, thousandths. A pattern is established. Beyond thousandths is read as whole number decimal individually list each number after the decimal to reduce any confusion. |
| c1, c2 | Focus is on two decimal places, decimals after the hundredths are ignored. Misconception may arise from the concept of money or measurement (looking at two only decimal places) | This problem can be drawn into two different concepts.  First of all, shading rectangular regions is the first step. Divide 1 into 3 equal parts and have the students shade 1/3. Aligned underneath this, have 1 divided into 6 equal parts and have the students shade 2/6. Do this for a variety of examples and students will recognise their equivalence.  A full understanding of the common fractions concept is critical before the introducing calculations.  With calculations (some time later) such as adding, introducing tenths is the first step, students will see the denominator as the same when adding. Then this can be extended to common fractions with the same denominator and then renaming the denominator can happen once confident at these earlier stages.  (Drawn from Booker et al, 2004, pp220-224). | Display 1 as a rectangular region a number of times in line with each other. Divide 1 into equal parts on each region. 1st divide into 5 equal parts, next region divide to 10 equal parts, next divide to 20 equal parts. Have students shade, 1st; 3/5, then 6/10, then 12/20. When the regions are in line, students will see they have the same value.  Practice this in a variety of ways.  Calculations of fractions (some time later with students who have good understanding of the meaning of fractions).  Linking between adding decimals, language and decimal fractions is the first step. Then extend with the use of common fractions with the same denominator. Adding with different denominators is drawn in much later. |
| e1, e2, d1 | Students may remember the rule ‘whatever you do to the top, you do to the bottom’ but may not be able to apply it in a context. This can lead to a lack of understanding of how to apply equivalency of fractions in a given context (i.e. 1/3 is equal to 2/6) | The lack of ability to apply the rule, ‘what you do to the top you do to the bottom’, may come around from the means by which equivalent fractions are taught. Booker et al (2004) explain that this rule is useful when students must find equivalent fractions, in order to add or subtract two fractions. However, this rule should not be taught straight away. Instead in order to teach students how to find equivalent fractions, students should first work with material aids and then work with visual representations, before beginning to learn how to find equivalent fractions with symbolic representations of fractions (Kennedy, Tipps & Johnson, 2008). By doing so students should be able to understand how the rule applies and why it is useful, as they will have an understanding of what the symbolic representation of a fraction means. | In order to approach teaching students how to find equivalent fractions, teachers should start with material and visual representations of fractions. For example:  - Subdividing rectangles.   |  |  | | --- | --- | |  |  |      |  |  | | --- | --- | |  |  | |  |  |   - The use of fraction walls  Demonstrate to students that one representation of a fraction can be equally subdivided, yet the area that is shaded is still the same. |
| c2 | Students may believe that the longer a decimal number, the larger the number. (i.e. 0.123456 is larger than 0.19) | In order to correct this misconception, teachers must ensure that students have a good understanding of using place value with decimals (Booker et al., 2004). Again, teachers should begin with physical representations of place value, before moving onto pictorial and then symbolic. | Begin with physical representations of decimal notation. Label 3 chairs in a row as ones, tenths and hundredths. Give students examples of numbers, asking them to stand behind each chair with their numbers. Define what each number is worth.  Move onto pictorial representations of decimal notation, using sliders and number expanders. |

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